MULTIFUNCTIONAL THERMAL INSTALLATION

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation of Application No. 10/038,034, filed on January 2, 2002, which is a continuation of International Application No. PCT/CN00/00172, which has an international filing date of June 23, 2000, and which was not published in English under PCT Article 21(2). The disclosures of these applications are incorporated herein by reference.

FIELD OF THE INVENTION

[0002] The present invention relates to a multifunctional thermal installation used to improve living conditions. The household multifunctional thermal installation is a multifunctional integrated system of air conditioning, heating, living hot water, and energy storage.

BACKGROUND OF THE INVENTION

[0003] The speed of economic development in the twentieth century has reached an unprecedented level. Although living conditions are improving, high-speed development can bring about adverse social effects that may be neglected by people until risks posed to the environment can hardly be recovered. No doubt exits that the twenty-first century will bring about even more developments thus generally improving the living conditions of people in the developing countries. However, one must note that improving the living conditions for people may come at a high cost to the environment. For instance, natural resources are being consumed to the extent that recovery may require the involvement of the international treaties within a limited period of time. Since the developing countries

are more populated than the developed countries, improvement of the living conditions in the developing countries according to the present model raises the issue whether the desired standard of living can ever be reached in the developing countries. In fact, the environmental problem in China has been placed on the agenda.

[0004] In some of the developing countries, most of the household installations use stand-alone systems, such as air conditioning, heating, and living hot water. Typically, such installations run on the consumption of non-renewable resources.

[0005] From a developmental point of view, the energy consumption for the household installations will increase as the standard of living rises. However, if every one of the household installations runs on the consumption of non-renewable resources, the household installations can directly or indirectly produce waste materials. Additionally, the household installations are used in a large quantity and can be found in a wide distribution area. Thus, the resulting environmental influence cannot be neglected. It must be noted that the demand for energy sources for the household installations can be low (i.e. the temperature difference between them is generally 20-30 °C).

[0006] Most of the non-renewable energy sources, however, can be replaced by renewable energy sources. For example, the installations that directly require large amounts of energy sources in ordinary life include air-conditioners, living hot water supply equipments, and heating equipments, while air-ventilators may require indirect energy demand. However, such requirements can increase in the future. From the point of view of social resources that are individually occupied, the consumption model may not be developed sustainably. Accordingly, new energy sources must be found to cover the shortage of the non-renewable energy sources.

[0007] At present, such household installations as aforementioned air-conditioners, heating equipments, and living hot water supply equipments use the system of central production and supply in developed countries. That is, such household installations run on the consumption of non-renewable resources. Therefore, the amount of non-renewable resources consumed by the developed countries is much larger than that consumed by the developing countries. In the same manner, so is the harm inflicted to the environment as well as the waste of the non-renewable resources.

SUMMARY OF THE INVENTION

[0008] The present invention provides a multifunctional thermal installation used to improve living conditions on the basis of the concept of sustainable development and ecological equilibrium. If the separate installations are made into an integrated system called a multifunctional system, a small amount of non-renewable energy source can be used and most of the energy sources can be replaced by the renewable energy sources collected from the multifunctional system. In this manner, the pollution created by the consumption of energy sources can be reduced effectively while large amounts of non-renewable energy sources can be saved and recovered.

[0009] The multifunctional thermal installation of the present invention includes a compressor, an evaporator, a condenser, and an expansion valve. The evaporator and the condenser each include at least a group of heat exchangers. A switch valve is provided at the end of the outlet of the compressor. The first group of heat exchangers is disposed within a water heater, while the second group of heat exchangers together with associated fans is disposed inside a room. The inlet of the water heater is connected to an underground well.

[0010] The switch valve at the outlet of the compressor of the present invention is connected to the heat exchanger inside the room to form a heat supply circulating device. However, the switch valve can also turn to the heat exchanger disposed in the water heater to form a refrigerating circulating device. The water heater can be an enclosed water tank with a hot water outlet and the compressor can be disposed inside the water heater. The water inlet of the water heater can be connected to an underground well through a pump.

[0011] In one embodiment, the operational principle of the multifunctional thermal installation is as follows: The multifunctional cold/hot air blower includes a fan and an

evaporating/condensing heat exchanger included in ordinary cold/hot air blowers. Furthermore, the structure of the multifunctional water heater is substantially the same as that of ordinary multifunctional water heaters. The compressor condensing process is used in the refrigeration process and the reverse cycle of the process is used in supplying heat to the multifunctional cold/hot air blower. As the operational principles of the foregoing heat supply devices are well known to one having ordinary skill in the art, no additional description of the operational principles of the heat supply shall be made herein. The combined installation is a multifunctional integration of a multifunctional blower, a compressor, and a multifunctional water heater. The multifunctional integration consumes about 10-20% of the absolute value of the total non-renewable energy resources of the system. Other energy resources needed by the multifunctional integration come from alternate energy resources. The integrated system is called a "multifunctional system."

[0012] When the integrated multifunctional system is in the refrigeration state, the refrigerating energy of the cold air blower comes from the water heater, wherein the heating energy of the water heater comes from the cold air blower. The residual thermal energy of the water heater is outputted and stored in the underground well for use as the primary thermal energy for heating in winter.

[0013] When the integrated multifunction system is in the heating state, the thermal energy of the hot air blower is supplied by the energy stored in the underground well in seasons that do not need heating. Meanwhile, the cold water from which the thermal energy has been absorbed by the hot air blower is stored in the underground well for future use, as the refrigeration source in summer.

[0014] The multifunctional thermal installation is an integrated accrete body wherein the cold/hot air blower and the multifunctional water heater constitute a common

thermal circulation capable of compensating each other, thus providing a compact structure.

[0015] Although the thermodynamic process of the multifunctional thermal installation can still use the circulating process of conventional compressors, the level of work required of the multifunctional thermal installation can be much lower than that of conventional air-conditioners. For instance, because the thermodynamic processes resulting from two functions are combined into one, the seasonal energy-efficiency ratio (SEER) can reach 10 or greater which can be more than two times that of conventional air-conditioners.

[0016] For example, the condensing temperature of approximately 40 °C and evaporating temperature of approximately 5 °C is used in conventional air-conditioners with R22 as a work medium, while the evaporating temperature used in the multifunctional thermal installation can be more than 12 °C and the condensing temperature can be about 20 °C or even lower.

[0017] From the users' point of view, the multifunctional thermal installations of the present invention occupy less space and are more convenient because air-conditioners are cold/hot air blowers without any outdoor equipments and boilers are used to supply living hot water into an enclosed container. In one embodiment, replacing separate household thermal installations with multifunctional thermal installations can reduce more than half of the energy consumption per capita in developed countries.

[0018] Furthermore, since the efficiency of the industrial installations in developed countries has reached a high level, reducing the emission index of the greenhouse gases may be difficult while civil installations are potential. In one embodiment, replacing separate installations with multifunctional thermal installations of the present invention

could efficiently reduce the emission index of the greenhouse gases in developed countries. Although, in one example, the cost/performance ratio of the multifunctional installation can be higher than that of the top-grade household appliances, promoting multifunctional thermal installations in developing countries can be advantageous. For instance, by using the one-step model, taking the road back using the development model of the developed countries may be avoided. Since nearly 100 million sets of household appliances are needed in developing countries every year, the promotion of multifunctional thermal installations in the developing countries can constitute a large-scale project of recovery of global warming. If conventional household appliances are still used, the greenhouse gases can increase at an order of magnitude of 100 million tons per year.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] Figure 1 shows a block diagram of a first embodiment according to the present invention.

[0020] Figure 2 shows a block diagram of a second embodiment according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0021] Referring to Figures 1 and 2, the present invention is a multifunctional thermal installation mainly including a compressor 1, an evaporator (or condenser) 3, a condenser (or evaporator) 6, an expansion valve 5, a switch valve 2, first and second group of heat exchangers 31 and 61, and a fan 33. A switch valve 2 is provided at the outlet of the compressor 1 of the present invention. In one embodiment, modifying the state of the switch valve 2 can result in creating the refrigeration system or the heating system. The evaporator and the condenser include first and second group of heat exchangers. As can be seen, one group of the heat exchangers 61 is disposed in a water heater 7 and the other group of the heat exchangers 31, together, with corresponding fans 33 are disposed inside a room 32. A water inlet of the water heater 7 is connected to a well 8.

[0022] The operational principle of the present invention is as follows: When refrigeration is needed, the water heater 7 collects water having a temperature of approximately 12-16 °C from the underground well 8. The switch valve 2 is located at the end of the outlet of the compressor 1 is connected to the heat exchanger 61, which is situated inside the water heater 7. After being compressed by the compressor 1, the cryogen is changed into high-temperature saturated gas having a temperature of more than 65 °C. The temperature of the cryogen is then lowered by the heat exchanger 61 after exchanging heat with the low-temperature water in the water heater 7. The condensed cryogen then enters the heat exchanger 31 disposed inside the room 32 to absorb a large amount of heat and be evaporated after being expanded by the expansion valve 5. At this point, the refrigeration process is finished. During the refrigeration process, the heat exchanger 61 functions as a condenser while the heat exchanger 31 functions as an evaporator, thus forming a cold air blower. During the heat exchange process, the

temperature of the low-temperature water situated in the water heater 7 can be changed into hot water having a temperature of 62 °C, providing hot water to be used, directly. Therefore, in one embodiment, refrigerating energy of the cold air blower comes from the water heater 7 and the thermal energy of the water heater 7 comes from the cold air blower. The residual thermal energy of the water heater 7 can be stored in the underground well 8 for use as the primary thermal energy for heating in winter.

[0023] Alternatively, the present invention can perform a heating process as shown in Figure 2. The water heater 7 collects warm water having a temperature of about 16-30 °C from the underground well 8. In one example, the water in the well has been heated by the heat stored in the well during the summer. As shown, the switch valve 2 located at the end of the outlet of the compressor 1 is connected to the heat exchanger 61disposed inside the water heater 7. The cryogen changes state into a high-temperature gas with a temperature of more than 55 °C. The cryogen supplies heat after the cryogen has been compressed by the compressor 1 and condensed by the heat exchanger 31. At this point, the heating process is finished. The condensed cryogen enters the heat exchanger 61 disposed inside the room 32 to absorb heat and to be evaporated subsequent to being expanded by the expansion valve 5. During the heating process, the heat exchanger 31 functions as a condenser while the heat exchanger 61 functions as an evaporator, thus forming a heating device. During the heat exchange process, the high-temperature water disposed in the water heater 7 can be changed into cold water having a temperature of approximately 1-2 °C. The cold water can then be used to refill the underground well 8 for use as the primary refrigerating energy in summer. Therefore, in one embodiment of the present invention, the heating energy of the hot air blower mainly comes from the energy stored in the underground well 8 during the warmer seasons. Thus, the water from which the thermal

energy has been absorbed by the hot air blower can be stored in the underground well 8 for use as the refrigerating energy during summer.

[0024] In summary, the combined installation of the present invention is an integrated accrete body wherein the cold/hot air blower and the multifunctional water heater constitute a common thermodynamic circulation by compensating each other. As a consequence, the multifunction thermal installation of the present invention is compact in structure. Since the thermodynamic processes of two functions are combined into one, the work condition of the multifunctional thermal installation is much lower than that of conventional air-conditioners, i.e., the seasonal energy-efficiency ratio (SEER) can reach 10 or greater, which is more than two times of that of conventional air-conditioners.

Embodiment 1:

[0025] The structure shown in Figure 1 is the first embodiment of the present invention. In this embodiment, the water heater 7 is an enclosed water container having a water inlet 71 that is connected to the underground well 8. Low-temperature water having a temperature of about 8-16 °C is pumped into the enclosed water heater 7 by a pump P. In one example, the compressor 1 can be disposed in the water heater 7. The switch valve 2 located at the end of an outlet of the compressor 1 is connected to the heat exchanger 61, which is disposed inside the water heater 7. After being compressed, the cryogen is changed into a gas work medium with the temperature as high as 65 °C. The high-temperature gas work medium can lower the temperature efficiently after exchanging heat with the low-temperature water in the water heater 7 through heat exchanger 61. In one example, the temperature of the cryogen can be as low as -4 °C. After being expanded through the expansion valve 5, the temperature of the cryogen can be lowered to -15 °C. At this point, the cryogen enters the heat exchanger 31 disposed inside the room 32 to

absorb the heat and be evaporated in the room 32 so as to finish the refrigerating process. In the circulation of the present embodiment, the heat exchanger 61 disposed in the hot water heater 7 functions as a condenser and the heat exchanger 31 disposed in the room 32 functions as an evaporator. During the condensation process, the low-temperature water disposed in the water heater can be heated without using any non-renewable energy sources, since the cryogen can give out a large amount of heat. Thus, the water disposed in the water heater 7 can have a temperature of approximately 62 °C and can flow out through the hot water outlet 72 disposed on the water heater 7 for use by the users. The residual hot water can be stored in the underground well 8 for use as the primary thermal energy for heating during winter.

Embodiment 2:

[0026] Figure 2 shows the second embodiment of the present invention. In this embodiment, the water heater 7 is an enclosed water container having a water inlet 71 that is connected to an underground well 8. Warm water having a temperature of approximately 16-30 °C that was stored in the underground well 8 during summer is pumped by the pump P into the water heater 7. In the illustrated embodiment, the compressor 1 is disposed inside the water heater 7. The switch valve 2 located at the end of the output of the compressor l is connected to the heat exchanger 3l disposed in the room 32. After being compressed, the cryogen is changed into a gas work medium having a temperature of about 55 °C. Then, cryogen in the from of gas work medium exchanges heat with the low-temperature air in the room 32 through the heat exchanger 31, thus forming a hot air blower. In one example, the temperature of the air outlet of the hot air blower can reach to approximately 55 °C, thus heating the room 32. After being expanded in the expansion valve 5, the cryogen which temperature has been lowered to

approximately -15 °C can enter the heat exchanger 61 to absorb heat and be evaporated. Thus, the water in the water heater 7 is changed into low-temperature water having a temperature of about 1-2 °C and is stored in the underground well 8 for use as the primary refrigerating energy in summer. In the circulation of the present embodiment, the heat exchanger 61 disposed inside the water heater 7 functions as an evaporator and the heat exchanger disposed in the room 32 functions as a condenser.

What is claimed is: